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TEMPORAL PATTERNS OF BEHAVIOR FROM THE SCHEDULING OF PSYCHOLOGY QUIZZES

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Temporal patterns of behavior have been observed in real-life performances such as bill passing in the U.S. Congress, in-class studying, and quiz taking. However, the practical utility of understanding these patterns has not been evaluated. The current study demonstrated the presence of temporal patterns of quiz taking in a university-level introductory psychology course and used these patterns to manage the traffic of quiz takers in a computerized testing lab. Results are discussed in terms of the applications of tracking temporal response patterns.

Key words: college students, deadlines, quiz taking, scallop, temporal patterns

When deadlines are imposed on performance, humans tend to respond very little when the deadline is temporally distant and at a positively accelerated rate as the deadline approaches (Malott, Whaley, & Malott, 1997; Michael, 1991). These temporal patterns of behavior, similar to the scallops observed in nonhumans on fixed-interval schedules, have been shown in naturally occurring performances such as bill passing in the U.S. Congress (e.g., Critchfield, Haley, Sabo, Colbert, & Macropoulis, 2003; Weisberg & Waldrop, 1972) and academic behavior of college students (e.g., Mawhinney, Bostow, Laws, Blumenfeld, & Hopkins, 1971; Michael; Ross & McBean, 1995). For example, Mawhinney et al. recorded the number of minutes that students spent studying in an optional study area when quizzes were given either daily or once every 3 weeks. Daily quizzing resulted in consistent patterns of study behavior, whereas less frequent quizzing resulted in the positively accelerated (scalloped) pattern described above. Similarly, Ross and McBean observed scalloped patterns of quiz-taking behavior when quizzes had an end-of-semester deadline.

These deadline-oriented patterns of behavior may produce undue strain on the larger systems in which they operate. This may be the case when the larger system has limited resources, as is the case with computerized testing centers. For example, if quiz deadlines are timed poorly, too many students may attempt to take their quizzes at one time. This would result in periods in which no students are taking their quizzes alternating with periods in which an unmanageable number of students attempt to take quizzes, limiting students' access to the testing environment.

Yet, it may be possible to use the predictable scalloped patterns of behavior generated by deadlines to promote efficient practices. For example, staggering deadlines may be an effective way to eliminate the high and low traffic periods associated with scalloped patterns of quiz taking in computerized testing labs. One way to accomplish this in large, multisection courses is to stagger the quiz deadlines across sections. The purposes of the current study were (a) to demonstrate positively accelerated (scalloped) patterns of quiz taking in 5 individual introductory psychology sections that used computerized testing and (b) to demonstrate that staggering deadlines across sections resulted

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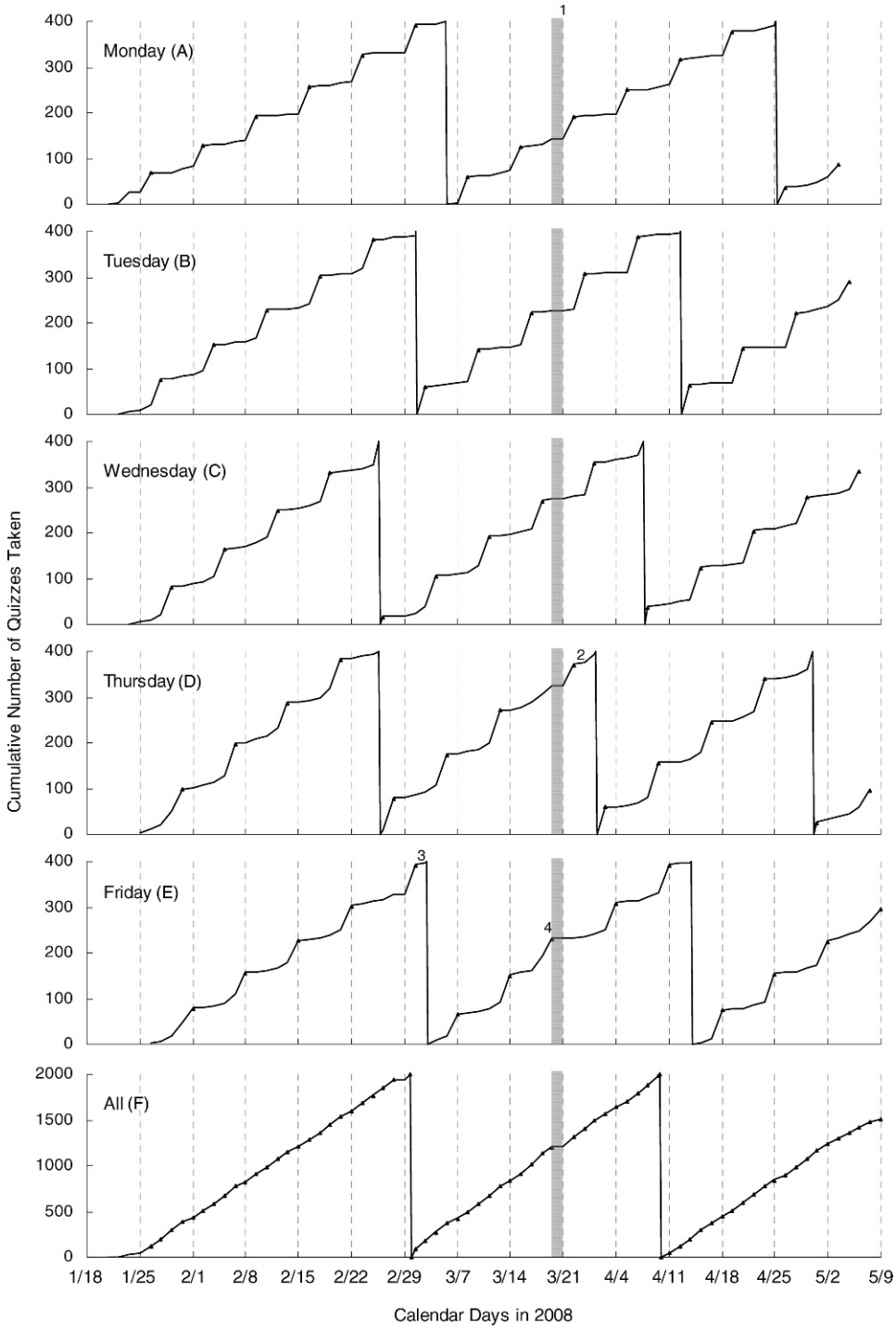

Figure 1. Cumulative introductory psychology quizzes taken for each of five sections with different weekly deadlines (Panels A through E, corresponding to Monday through Friday) and the sum of all five sections (Panel F). The *y* axis corresponds to the number of cumulative quizzes taken and resets every 400 quizzes for Panels A through E and at 2,000 quizzes for Panel F. Tick marks represent quiz deadlines. The *x* axis represents calendar days in 2008, excluding weekends

in steady overall rates of quiz taking in a computerized testing lab.

METHOD

All participants were students in an introductory psychology course taught 2 or 3 days per week during the Spring 2008 semester. Although a total of 13 sections participated, each containing 90 to 117 students, the data from five representative sections are presented for ease of interpretation. These sections were chosen because (a) they had a quiz deadline on each day of the week and (b) the time of the deadline was the latest in each day. All quizzes were administered using WebCT Version 4.0 in a computerized testing lab that was staffed by course instructors. The testing lab, equipped with 59 computers, was available to the students for 6.5 hr on Monday, 8 hr on Tuesday, 6 hr on Wednesday, 6.5 hr on Thursday, and 5 hr on Friday during each week of the semester (see Results section for exceptions).

The syllabus stated and lectures emphasized that all quizzes would be administered in the testing lab. Instructors explained how to use the system during the 1st week of class, and an orientation quiz was given prior to the administration of the first quiz to acquaint the students with the system. Each quiz consisted of a series of 25 multiple-choice questions about the material covered in a single chapter. When a student selected a quiz, the quizzing program automatically recorded the time and date of quiz initiation for later analysis; these data were the primary dependent measure for the current investigation.

The quizzes taken in the lab accounted for 74% of each student's total grade (the remainder of the grade was based on the student's performance on in-class activities). During class meetings, all instructors encouraged students to take the quizzes on time and were explicit about the deadlines and consequences for missing them (i.e., no makeup quizzes, but the student may miss three quizzes without penalty). Furthermore, information about quiz deadlines was available on the course Web site.

To examine deadline-oriented temporal patterns of behavior, each quiz was available for 1 week. When a quiz was available, students could see and select the quiz in the online environment; when a quiz was unavailable, it was not visible in the online environment, and the students could not take the quiz.

To examine traffic flow into the testing center in accordance with expected temporal patterns of quiz taking, the periods of quiz availability remained consistent within sections but were staggered across sections. That is, each section had a regularly recurring deadline, but the deadline for each reported section's quiz was on a different day. For example, the first quiz on chapter 1 was due by Monday, January 28, 2008, in the section with Monday deadlines, by Tuesday, January 29, in the section with Tuesday deadlines, and so on.

RESULTS AND DISCUSSION

Figure 1 shows the cumulative number of quizzes taken for each of five sections with different weekly deadlines (Panels A through E, corresponding to Monday through Friday) and the sum of all five sections (Panel F). The *y* axis represents the cumulative number of quizzes taken since the beginning of the semester and resets every 400 quizzes for Panels A through E and at 2,000 quizzes for Panel F. This different scale for resetting was employed to approxi-

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and spring recess (March 24 through 28). Dashed vertical lines represent weekend breaks. The gray bars (1) on March 21 represent a day the university was closed. The quiz deadline was extended for Sections D and E at 2 and 3, respectively. The quiz deadline was shortened for Section E at 4.

mately equate the number of resets across the panels. The *x* axis represents calendar days in 2008, excluding weekends and spring recess (March 24 through 28). The tick marks and the dashed vertical lines represent quiz deadlines and weekend breaks, respectively.

In general, positively accelerated patterns of quiz taking were observed across all sections. For the quizzes closing on Monday, for example, relatively few quizzes were taken on Tuesday through Thursday, with the number of quizzes taken accelerating on Friday and Monday (see below for some exceptions to this general finding). Similarly, for the quizzes closing on Tuesday, relatively few quizzes were taken on Wednesday through Friday, with the number of quizzes taken accelerating on Monday and Tuesday, and so on. These temporal patterns of behavior were consistent with those previously observed in the work habits of the U.S. Congress (e.g., Critchfield et al., 2003; Weisberg & Waldrop, 1972), the observations regarding study habits (Mawhinney et al., 1971; Michael, 1991), and patterns of quiz taking associated with end-of-semester deadlines in college students (Ross & McBean, 1995).

The maintenance of the scalloped patterns despite idiosyncratic modifications of deadlines due to nonexperimental events further highlights the strong control exerted by the deadlines on response patterns. For instance, in the section with Thursday deadlines, the deadline for the eighth quiz was shifted to the following Monday. As indicated by 2 on Panel D, the acceleration of the number of quizzes taken was steepest on that Monday. Likewise, the deadline for the eighth quiz was shifted forward to the previous Thursday (4 on Panel E) in the section with Friday deadlines, which resulted in the steepest acceleration of the number of quizzes taken on that Thursday. Finally, when the deadline for the fifth quiz in the section with Friday deadlines was unpredictably extended for a day due to technical difficulties in the testing center (3 on Panel E), the positively accelerated pattern of responding was observed right before the new deadline.

There were some exceptions to the scalloped pattern of responding. A break-and-run pattern (high rates of behavior followed by periods with no responding; Ferster & Skinner, 1957) was sometimes observed in the sections with Monday or Tuesday deadlines (e.g., the 4th week in Panel A). It is possible that deadline-oriented patterns of responding may have been disrupted by the weekend in these cases. Future research could examine the effects of temporary removal of the opportunity to respond (as is the case with weekends for quiz taking) on deadline-oriented behavior to help determine the reason for the break-and-run pattern observed with these two sections. These findings suggest that, because overall traffic flow can be moderated by staggering deadlines, there is a practical utility to understanding the temporal patterns of responding associated with deadlines. These findings suggest that, because overall traffic flow can be moderated by staggering deadlines, there is a practical utility to understanding the temporal patterns of responding associated with deadlines.

Due to practical constraints, we were unable to conduct conditions without deadlines or conditions in which the deadlines were not staggered. Hence, although we were able to demonstrate control by deadlines (i.e., through replication across five sections), there is no baseline for comparison. Future studies that are free from the constraints of a large multisection university course should include such controls.

Although this study was conducted in the context of an introductory psychology course, the findings may have implications for the management of other deadline-oriented behavior (e.g., filing tax returns, submitting abstracts for conference presentations, performance management techniques). For example, if deadline-oriented contingencies, in which employees receive extra pay for meeting deadlines, were

to be used to assure that restrooms are cleaned in a restaurant, the scalloped pattern of cleaning generated may yield an unacceptable state of restroom cleanliness when the deadline is temporally distant and a spotless restroom as the deadline approaches. Hence, although the contingencies are met, restroom conditions may be repulsive to diners during portions of the performance period. This outcome could be avoided by staggering the cleaning deadlines across employees. Future research could demonstrate and alter the temporal patterns of deadline-oriented behavior associated with these and other naturally occurring responses.

The current findings demonstrated temporal patterns of behavior associated with deadlines, but the mechanism behind these patterns is unclear. It has been suggested that these patterns of behavior are associated with negative reinforcement in the form of avoidance of the loss of a positive reinforcer (Malott, 2005). Hence, in the current study, quiz taking may be controlled by avoidance of the loss of the points associated with taking the quizzes. Although a comprehensive examination of the processes that underlie these patterns is currently absent from the literature, studies of avoidance have demonstrated similar patterns. For example, Baron and Galizio (1976) found that, for humans, the rate of responding on a free-operant avoidance schedule was positively related to the proportion of the interval that had passed, especially when temporal cues were made explicit through the addition of clock stimuli. This similarity in patterns observed on avoidance schedules and in association with deadlines supports Malott's analysis. Basic research that definitively examines this phenomenon is needed to make stronger statements about the maintenance of these patterns of behavior.

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